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Cardinal Soft Red Winter Wheat

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Contents

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Cardinal, a new, high yielding soft red winter wheat, was developed and released for production in Ohio and the Midwest by the Ohio Agricultural Research and Development Center, The Ohio State University. Cardinal was officially released in 1986 to Certified seed producers with limited quantities of seed first available to farmers for fall, 1987 seedings. The name, Cardinal, was chosen for two reasons: (1) it is the state bird of Ohio and (2) the word has the meaning of major or principal importance. Cardinal was previously designated as OH 244 in various publications concerning the wheat breeding program in Ohio.

Breeding Origin

Cardinal originated from the complex cross: LoganX[LoganX[(Va63-52-12XLogan)XBlueboy]], which was completed in 1971. Cardinal traces back to a single F_3 plant selected in 1974, however, it was reselected in 1981 in the F_{10} generation. The pedigree, 2071ABC-12, was used to designate this line in early tests until it was assigned the advanced line designation, OH 244, in 1979.

Breeder seed consists of the progeny of 39 F_{10} plants selected for uniformity and yield in 1981 through 1984, then bulked following the 1984 harvest. Breeder seed was first produced in the 1985 season followed by the first production of Foundation generation seed in 1986 in Ohio, Indiana, and Illinois.

Performance

Tables 1 and 2 summarize yields of Cardinal in state-wide, drilled plot trials conducted in Ohio from 1981 through 1987. Thirty-eight replicated drilled plot trials have been conducted comparing Cardinal with other varieties in production in Ohio. Yearly average yields at three to seven locations are summarized in Table 1 while location averages over a period of years are summarized in Table 2.

As shown in Tables 1 and 2, Cardinal has exhibited excellent yields in comparison to currently grown varieties in these trials over the seven year test period. Cardinal ranked first among all varieties presented in Table 1 in four of the seven years as well as in the 38 test average. Its nearest competitor is Becker, a variety released from our program one year earlier. In the location summary reported in Table 2 there is no strong evidence that Cardinal performs relatively better or worse than other varieties in a particular region of the state, however, there is some hint of relatively

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superior performance in more westerly locations when Cardinal location mean yields are compared to the location averages of the other three varieties in Table 2. Data from trials conducted in other states tend to substantiate this observation.

Table 3 summarizes a three year high yield study involving Cardinal, Becker, Tyler, and Caldwell at Wooster, Ohio. These trials were conducted to determine yield and lodging response of these varieties to extremely high nitrogen rates under optimum management conditions. The extremely high nitrogen rates used in this study are not recommended for farm production, but rather were used to determine the upper limits of yield response and straw strength. In this study Cardinal appears superior to Tyler and Caldwell in both yield potential and straw strength, however, it appears not as well suited to high yield environments as Becker. The cause of Becker's superior yield performance in these studies is thought to be due to its extreme straw strength and associated reduced lodging as well as its excellent response to the use of a fungicide to control foliar diseases, normally a problem with Becker under high fertility conditions. Cardinal should be the variety of choice where high fertility conditions exist, but fungicide application is not planned.

Other performance data are summarized in Tables 4 and 5 and discussed below.

Winterhardiness

Cardinal has exhibited excellent winterhardiness (Table 4) with winter survival scores equal to the most hardy varieties now grown in this region. In rigorous tests in the upper Midwest, Cardinal has exceeded numerous other soft wheat varieties in survival except the Wisconsin-developed variety, Charmony.

Straw Strength

Cardinal has exhibited excellent straw strength in Ohio (Table 4) and region-wide tests, exceeding all currently grown public varieties except Becker and Scotty. The straw strength of Cardinal is exceptional since it is several inches taller than several varieties, but exceeds them in straw strength.

Characteristics

A midseason maturity variety, Cardinal heads on average the same date as Becker, three days earlier than Titan, and three days later than Caldwell.

Plant height of Cardinal has averaged five inches taller than Caldwell, and one inch shorter than Titan and Hart. The combination of excellent straw strength and moderate height makes Cardinal an excellent choice where good straw yields are important along with high grain yields.

Table 1. Comparative yields (bu/a) of Cardinal and other currently grown cultivars in drilled plot trials by years, Ohio.

Entry	1981 3 tests	1982 3 tests	1983 7 tests	1984 6 tests	1985 6 tests	1986 7 tests	1987 6 tests	Avg. 38 tests	Avg. 32 tests	Avg. 19 tests
Adena	55.9	63.1	58.1	57.7	76.4	55.2[1]	—	—	61.1	—
Becker	57.3	66.3	63.5	56.5	83.3	58.2	64.6	64.5	64.4	61.4
Caldwell	58.6	60.9	—	—	—	55.2	60.1	—	—	58.2
Cardinal	60.6	64.9	64.3	63.5	84.0	56.6	64.5	65.7	65.9	61.0
Hart	56.4	68.9	57.7	55.3	78.3[1]	56.2	—	—	61.7	—
Titan	58.0	62.3	60.1	51.3	77.9	55.9	57.9	60.4	60.9	57.9
Tyler	58.5[1]	70.2	64.2	57.5	75.3	57.9	61.0	63.3	63.7	60.9

[1]No data for this single year. Adjusted values reported are based on relative performance in remaining years.

Table 2. Comparative yields (bu/a) of Cardinal and other currently grown cultivars in drilled plot trials by location, Ohio.

Entry	OARDC Wooster 1981-87	N. W. Br. Custar 1981-87	W. Br. S.Charleston 1981-87	Mah. Co. Canfield 1983-87	S. Br. Ripley 1983-87	O.F.S. Croton 1983,86	Veg. Cr. Br. Fremont 1983-87	Avg. (38 tests)
Becker	66.0	73.3	60.5	53.5	52.6	57.6	81.2	64.5
Cardinal	67.0	77.9	59.0	54.0	54.3	58.6	81.9	65.7
Titan	62.1	67.1	54.9	54.9	48.0	57.8	75.5	60.4
Tyler[1]	68.0	72.3	56.3	52.7	46.3	59.4	82.9	63.3

[1] No 1981 data. Adjusted values reported are based on relative performance in remaining years.

Table 3. Results of high yield studies involving Cardinal, Becker, Tyler, and Caldwell at three spring nitrogen topdressing rates, 1985-87, Wooster, Ohio.

Variety-Treatment[1]	Yield (bu/a)[2]				Lodging (%)			
	1985	1986	1987	Avg.	1985	1986	1987	Avg.
Cardinal— 60 lb/a N	93[c]	71[ab]	71	78.3	0	19	46	22
Cardinal— 120 lb/a N	101[b]	64[d]	69	78.0	19	80	80	60
Cardinal— 180 lb/a N	101[b]	65[cd]	67	77.7	26	88	66	60
Becker— 60 lb/a N	98[b]	72[a]	78	82.7	0	7	11	6
Becker— 120 lb/a N	107[a]	69[ab]	81	85.7	15	93	66	58
Becker— 180 lb/a N	110[a]	65[cd]	80	85.0	15	93	69	59
Tyler— 60 lb/a N	86[e]	68[bc]	76	76.7	7	68	59	45
Tyler— 120 lb/a N	88[de]	57[ef]	71	72.0	53	98	86	79
Tyler— 180 lb/a N	91[cd]	55[f]	72	72.7	53	98	89	80
Caldwell— 60 lb/a N	88[de]	68[bc]	70	75.3	13	79	82	58
Caldwell— 120 lb/a N	91[cd]	59[e]	64	71.3	81	100	99	93
Caldwell— 180 lb/a N	93[c]	60[e]	63	72.0	78	100	99	92

[1]Bayleton applied to all plots at late boot stage (4 oz/a). Nitrogen applied in split applications; half in mid-March and half in mid-April.
[2]Means followed by the same letter within each column are not significantly different at the 5% level of significance. In 1987 variety-treatment effects were non-significant.

Table 4. Comparative agronomic performance of Cardinal and currently grown varieties in drilled plot trials, Ohio, 1981-1987. (Average of 38 tests.)

Variety	Winter Survival (%)	Lodging (%)	Date Headed (May)	Pl. Height (in.)	Test Wt, (lb/bu)
Becker	95	3	25	31	55.9
Cardinal	96	5	25	36	57.4
Titan	94	16	28	37	56.7
Tyler[1]	96	10	25	37	56.8

[1]No 1981 data. Adjusted values reported are based on relative performance in remaining years.

Table 5. Comparative Hessian fly, disease, aluminum tolerance, and quality ratings of Cardinal and currently grown varieties in miscellaneous Ohio tests.

	Al tolerance							
	Yield (% of Seneca (tolerance)	Visual	% Mildew 18 tests	WSSM[3] 5 tests	Leaf Rust[4] 13 tests	H.F. Res.	Quality Grade 1981-87	
Variety	1980,81,83,86	score[2] 1981-86	1981-87	1981-84	1983-87	(Races)	Milling	Baking
Becker	69	4	68	1	10 MR	A,C	B–	B
Cardinal	99	4	30	1	1 VR-R	A,C	A+	B+
Titan	75	4	23	2	16 MS	A,C	B–	E
Tyler[1]	—	3	1	1	52 S	None	A	E

[1]No 1981 data. Adjusted values reported are based on relative performance in remaing tests.
[2]0= very tolerant to 9=sensitive.
[3]0=none to 9=severe.
[4]Percent of flag leaf infected followed by pustule type where S=susceptible,MS=moderately susceptible, MR=moderately resistant, R=resistant, VR=very resistant.

Test weight of Cardinal is rated as high, averaging .6 to .7 pounds per bushel heavier than Titan and Tyler and 1.5 pounds per bushel heavier than Becker. Cardinal has also averaged .3 pounds per bushel heavier than Caldwell in common tests.

Cardinal is highly tolerant to acid soil conditions, exhibiting a tolerance level of 99 percent of that of Seneca, an extremely tolerant old variety used as a check in tests on highly acid soils over four years (Table 5). No other currently grown variety tested has performed as well on acid soils as Cardinal

Cardinal is an awnless variety, but possesses apical awnlets. During the vegetative growth stages it possesses dark green foliage. At maturity its large, fusiform heads are held mostly erect and possess white chaff. Straw color is yellow. Cardinal most closely resembles Titan in field appearance, but normally is shorter, earlier, and exhibits larger heads. It also exhibits a more erect growth habit than Titan as a juvenile plant.

Insect and Disease Resistance

Cardinal has shown only moderate resistance to field races of powdery mildew in the juvenile plant stage, but appears to possess good adult plant resistance (Table 5). It is highly resistant to wheat spindle streak mosaic virus (WSSM) and possesses excellent resistance to currently prevalent races of leaf rust. It also appears highly resistant to natural infections of loose smut. Although not adequately evaluated in Ohio tests to report reliable ratings, other midwestern tests have rated Cardinal as moderately resistant to septoria leaf blotch. Reactions of Cardinal to other minor Ohio diseases have not been adequately evaluated to report. Cardinal possess resistance to races A and C of Hessian fly, however, this resistance offers only partial protection against the current races of Hessian fly occurring in Ohio.

Milling and Baking Quality

In tests conducted over seven years involving composited samples from several locations submitted to the USDA Soft Wheat Quality Laboratory, Cardinal has proven to have excellent milling and baking quality (Table 5). Milling quality scores have consistently exceeded all currently grown varieties while baking quality scores have exceeded all current varieties except Caldwell. In four years of common tests Cardinal baking scores were equal to those of Caldwell.

Grain Quality

Under normal growing conditions Cardinal produces large, long, plump kernels of high quality and excellent appearance. Kernel weight of Cardinal normally appears highest of all currently grown varieties. Due to its large seed size it is advisable to increase seeding rates slightly above those used

for most other varieties in order to produce the same number of plants per acre. This is especially advisable where late seedings are made or poor seedbed conditions exist.

In 1987 an unusual period of persistent rains occurred at the beginning of the normal wheat harvest period in northern Ohio resulting in considerable pre-harvest sprouting in Cardinal and a few other varieties. While no previous sprouting problems had been observed in Cardinal it appears advisable to harvest Cardinal as soon after maturity as possible to avoid sprouting damage and reduced test weight.

Plant Variety Protection

Plant variety protection (Application No. 8700146) has been applied for and was approved in September, 1988. Seed of Cardinal may be sold or offered for sale only as a class of certified seed and must be labeled as a protected variety. Three generations of certified seed are allowed beyond breeder seed, namely, foundation, registered, and certified classes.

Availability

Certified seed of Cardinal should be widely available from certified producers or seed retailers in Ohio, Indiana, Illinois, and possibly other states over the next several years. Breeder seed of Cardinal will be maintained by the Ohio Agricultural Research and Development Center, The Ohio State University, Wooster, OH, 44691. Cardinal has been accessioned as P.I. 502973 in the USDA wheat collection.

Summary

Cardinal appears well suited for production over a wide range of environments and production conditions. As with most new varieties, Cardinal will find its own niche in the marketplace, however, it appears to be an excellent candidate to replace Titan, Logan, and other midseason varieties in Ohio and to extend its acreage throughout the Midwest.

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